REMARKS

Reconsideration of the present application in view of the above amendments and following remarks is respectfully requested. Claims 1, 2, 3 and 4 have been amended, and new claims 9-19 have been added. Therefore, claims 1-19 are pending in the application.

Amendments to the Specification

In view of the amendments to the claims, which as discussed below are clearly supported by the specification, Applicant has amended the Title and Summary of the Invention in order to make them commensurate with the invention as claimed, as suggested by 37 C.F.R. § 1.73.

Claim Rejections under 35 U.S.C. § 112

The Examiner has rejected claims 3 and 4 under 35 U.S.C. § 112, first paragraph. Applicants respectfully traverse this rejection. In the interest of furthering the issuance of the remaining pending claims in the application, claims 3 and 4 have been amended to remove the language objected to by the Examiner. Thus, this rejection is overcome.

Claim Rejections under 35 U.S.C. § 102

The Examiner has rejected claims 1-3 under 35 U.S.C. § 102(b). Claims 1-3 stand rejected as being anticipated by U.S. Patent No. 5,821,659 (Smith). Additionally, the Examiner asserts claims 1-3 are anticipated by U.S. Patent No. 4,271,369 (Stillwagon). Applicants respectfully traverse these rejections.

Claim 1:

Applicants have amended independent claim 1 to recite "means for maintaining substantially constant contact pressure of the current collectors with the armature conductor turns in the presence of high magnetic fields produced by

superconducting field coils". This amendment is supported by Applicants' originally filed claim 1 as well as their specification, which states in pertinent part:

> "The field coils 110, 112, which provide the background magnetic field, may be resistive electromagnet coils or superconducting coils. As will be discussed below, the strength of each of the field coils 110, 112 is varied, and therefore, permanent magnets are not used for the field coils 110, 112. Preferably, the field coils 110, 112 are circumferentially continuous in geometry and are superconducting coils that are formed from circumferentially wrapped electrically superconducting wire. Superconducting coils are the preferred choice due to the higher magnetic fields that may be produced, which results in a smaller and lighter motor."

(Applicants' specification, page 8, lines 10-17).

In previous homopolar machines that did not utilize superconducting field coils, maintaining current collector pressure presented less of a challenge. In a homopolar machine of a type described in Applicants' specification that uses superconducting field coils, however, the maintenance of substantially constant contact pressure is more difficult in the presence of the high magnetic fields that are achievable only with superconducting field coils. Applicants recognized and solved this problem in their application.

The Examiner has not identified anything in Smith that discloses or suggests a means for maintaining substantially constant contact pressure of the current collectors with the armature conductor turns in the presence of high magnetic fields produced by superconducting field coils. Furthermore, Applicants have found nothing in Smith that indicates the use of superconducting field coils.

Stillwagon states the following:

> "The excitation windings 16 are positioned radially outward from adjacent ends of the rotating sleeves and each winding comprises superconducting excitation coils to provide the needed high energy magnetic fields. To achieve superconductivity, the excitation coils are wound with a composite conductor preferably consisting of niobium-

> titanium alloy superconducting filaments embedded in a copper matrix with conventional turn-to-turn insulation and ground insulation."

(Stillwagon, col. 6, line 62 to col. 7, line 2).

While Stillwagon mentions the use of superconducting excitation coils, Applicants submit that the Examiner has not identified in Stillwagon a means for maintaining substantially constant contact pressure of the type described in Applicants' specification.

Therefore, Applicants submit that the rejection of amended independent claim 1 should be withdrawn. Furthermore, claim 3 is allowable by virtue of its dependence from claim 1.

Claim 2:

Applicants have amended claim 2 to place it in independent form, including all of the limitations of the original, unamended claim 1. Applicants have also made a couple of other minor amendments to claim 2 that can be seen in the marked-up version of the amendment. In rejecting claim 2, the Examiner contends that a portion (not numbered) of Smith's outer flux return 49 directs magnetic field lines 51 substantially parallel to the (radially-directed) current flowing at the interface between collectors 23 and conductor turns 21. The Examiner also contends that a portion of Stillwagon's flux path travels parallel to the current flowing at the interface between brushes and slip rings. The Examiner, however, appears to have disregarded some of the other limitations that are included in claim 2. Namely, the Examiner has not identified anything in Smith or Stillwagon that discloses "reduc[ing] induced magnetic forces that may deflect the current collectors", as is recited in Applicants' amended claim 2.

Reducing induced magnetic forces that may deflect the current collectors helps the current collectors to maintain substantially constant contact pressure with the armature conductor turns in the presence of high magnetic fields. Applicants discussed this in their specification, which states in pertinent part:

> "The current collector pressure, however, can be undesirably affected by forces generated on it due to current flowing through it in the presence of a magnetic field. In the present invention, the flux return geometry and field coil configuration are designed so that the magnetic field lines are substantially in the same direction as the direction of the current flow through the current collectors 132, i.e., radially outward. Since the current flowing through the current collectors passes substantially parallel to the field lines, minimal force (I x B) is induced on the flexible collectors 132. The force is minimal enough such that the flexible collectors 132 are not deflected enough to change the contact pressure enough to significantly degrade performance."

(Applicants' specification, page 13, lines 8-17).

Applicants submit that neither Smith nor Stillwagon teach a current collector which maintains a constant contact pressure with the armature by using field line orientation to reduce the induced magnetic forces on the current collectors while current is flowing through them. Additionally, neither Smith nor Stillwagon have any motivation for "reduc[ing] induced magnetic forces that may deflect the current collectors" as claimed by Applicants because those references do not appear to be trying to use the orientation of the field lines to aid in maintaining a constant contact pressure between the current collectors and the armature in the presence of high magnetic fields. Because neither Smith nor Stillwagon teach the claimed invention, nor do they show any motivation to modify the reference to show Applicants' claimed invention, Applicants submit the rejection of claim 1 has been overcome.

Additionally, Applicants have added new independent method claim 9 which recites the step of "reducing induced magnetic forces that may deflect the current collectors . . .". New independent method claim 9 is supported by original claims 1 and 2. Applicants have also added new independent method claim 17 which recites "to reduce induced magnetic forces on the current collectors" and which also recites "energizing superconducting field coils". New independent method claim 17 is supported by original claims 1 and 2, as well as the following language in Applicants' specification:

> "Furthermore, the field lines are oriented substantially parallel to the direction of the current flow in the stator-current collector arrays 108 region (radially outward). This orientation minimizes the force exerted on the current collectors 132 in the circumferential direction by minimizing the current and field line (I x B) force."

(Applicants' specification, page 10, lines 12-16).

Thus, in various embodiments of Applicants' invention the orientation of the field lines helps reduce the force exerted on the current collectors. Applicants submit that new independent claims 9 and 17 are allowable for substantially the same reasons as amended claim 2.

Claim Rejections under 35 U.S.C. § 103

The Examiner has rejected claims 4-8 under 35 U.S.C. § 103(a). Claims 4-8 stand rejected as being unpatentable over U.S. Patent No. 5,821,659 (Smith) or U.S. Patent No. 4,271,369 (Stillwagon) in view of U.S. Patent No. 6,245,440 (Kuhlmann-Wilsdorf et al.). Applicants respectfully traverse these rejections.

The rejection as applied to claim 1 is traversed as explained above. Therefore, claims 4-8 are allowable by virtue of their dependence from claim 1.

New Claims

Applicants have added new claims 9-19. Support for the new claims can be found in the drawings and throughout the originally filed specification.

Fee that is Due

When this application was filed a fee was paid for a total of 20 claims and 3 independent claims. The above amendment has resulted in there now being a total of 19 claims and 4 independent claims. Thus, a fee is now due for 1 extra independent claim.

Marked up Version of the Claims

Attached to the end of this paper is a "Version with Markings to Show Changes Made" that shows the amendments made to the specification and claims.

CONCLUSION

In view of the above, Applicants submit that the pending claims are in condition for allowance, and prompt and favorable action is earnestly solicited. Applicants have made a diligent effort to place the claims in condition for allowance. However, should there remain any outstanding issues that require adverse action, it is respectfully requested that the Examiner telephone Richard E. Wawrzyniak at (858) 552-1311 so that such issues may be resolved as expeditiously as possible.

Respectfully submitted,

FITCH, EVEN, TABIN & FLANNERY

Dated: 11/22/02

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VERSION WITH MARKINGS TO SHOW CHANGES MADE

In the Title:

Delete the TITLE OF THE INVENTION section and replace such deleted section with the following replacement TITLE OF THE INVENTION section:

REDUCTION OF INDUCED MAGNETIC FORCES ON CURRENT COLLECTORS IN HOMOPOLAR MACHINES HAVING HIGH MAGNETIC FIELDS [~~HOMOPOLAR MACHINE WITH SHAFT AXIAL THRUST COMPENSATION FOR REDUCED THRUST BEARING WEAR AND NOISE~~]

In the Specification:

Delete the SUMMARY OF THE INVENTION section beginning on page 4, line 14 and replace such deleted section with the following replacement section:

SUMMARY OF THE INVENTION

The present invention advantageously addresses the needs above as well as other needs by providing [~~an apparatus that includes a homopolar machine. The homopolar machine includes a shaft, an armature assembly coupled to the shaft, an outer flux return that encloses the armature assembly, an inner flux return coupled to the shaft, and means for producing a magnetic field asymmetry within the inner flux return that produces an axial force on the shaft.~~

~~Another aspect of the present invention provides a method of operating a homopolar machine. The method includes the steps of energizing a first field coil in the homopolar machine to a first excitation level; and energizing a second field coil in the homopolar machine to a second excitation level that is different than the first excitation level to produce a magnetic field asymmetry within the homopolar machine that produces an axial force on a shaft of the homopolar machine.~~

~~And another aspect of the present invention provides~~] a homopolar machine that includes a shaft, an armature assembly, an outer flux return, and a plurality of stator-current collector arrays. The armature assembly is coupled to the shaft and includes a plurality of armature conductor turns. The outer flux return encloses the armature assembly. The plurality of stator-current collector arrays are coupled to the outer flux return and encircle the armature assembly. Each stator-current collector array includes a plurality of current collectors that [~~maintain substantially constant contact pressure with the armature conductor turns in the presence of high magnetic fields to~~] provide a sliding electrical current interface with the armature conductor turns. Means are provided for maintaining substantially constant contact pressure of the current collectors with the armature conductor turns in the presence of high magnetic fields produced by superconducting field coils.

Another aspect of the present invention provides a homopolar machine that includes a shaft, an armature assembly, an outer flux return, and a plurality of stator-current collector arrays. The armature assembly is coupled to the shaft and includes a plurality of armature conductor turns. The outer flux return encloses the armature assembly. The plurality of stator-current collector arrays are coupled to the outer flux return and encircle the armature assembly. Each stator-current collector array includes a plurality of current collectors that maintain substantially constant contact pressure with the armature conductor turns in the presence of high magnetic fields to provide a sliding electrical current interface with the armature conductor turns. The outer flux return comprises a geometry that directs magnetic field lines substantially parallel to a direction of current flow in a region where the plurality of current collectors contact the armature conductor turns to reduce induced magnetic forces that may deflect the current collectors.

Another aspect of the present invention provides a method of operating a homopolar machine that includes the steps of: rotating an armature assembly that includes a plurality of armature conductor turns; creating a magnetic field through the armature assembly; providing a plurality of stator-current collector arrays that encircle

the armature assembly, each stator-current collector array including a plurality of current collectors which provide a sliding electrical current interface with the armature conductor turns; reducing induced magnetic forces that may deflect the current collectors by directing magnetic field lines substantially parallel to a direction of current flow in a region where the plurality of current collectors contact the armature conductor turns; and maintaining substantially constant contact pressure between the plurality of current collectors and the armature assembly in the presence of the magnetic field.

Another aspect of the present invention provides a method of operating a homopolar machine that includes the steps of: energizing superconducting field coils in the homopolar machine to create a magnetic field through an armature assembly that includes a plurality of armature conductor turns; supplying current to a plurality of current collectors that provide a sliding electrical current interface with the armature conductor turns; and maintaining an orientation of the plurality of current collectors and the magnetic field so that magnetic field lines are directed substantially parallel to a direction of current flow in a region where the plurality of current collectors contact the armature conductor turns to reduce induced magnetic forces on the current collectors.

In the claims:

Please AMEND claims 1, 2, 3 and 4 as follows:

1. (Amended) A homopolar machine comprising:

a shaft;

an armature assembly, coupled to the shaft, that includes a plurality of armature conductor turns;

an outer flux return that encloses the armature assembly; [~~and~~]

a plurality of stator-current collector arrays, coupled to the outer flux return, that encircle the armature assembly, each stator-current collector array including a plurality of current collectors that [~~maintain substantially constant contact pressure with the armature conductor turns in the presence of high magnetic fields to~~] provide a sliding electrical current interface with the armature conductor turns; and

means for maintaining substantially constant contact pressure of the current collectors with the armature conductor turns in the presence of high magnetic fields produced by superconducting field coils.

2. (Amended) A homopolar machine comprising:

a shaft;

an armature assembly, coupled to the shaft, that includes a plurality of armature conductor turns;

an outer flux return that encloses the armature assembly; and

a plurality of stator-current collector arrays, coupled to the outer flux return, that encircle the armature assembly, each stator-current collector array including a plurality of current collectors that maintain substantially constant contact pressure with the armature conductor turns in the presence of high magnetic fields to provide a sliding electrical current interface with the armature conductor turns;

[~~A homopolar machine in accordance with claim 1,~~] wherein the outer flux return comprises a geometry that directs magnetic field lines substantially parallel to a direction of current flow in a region where the plurality of current collectors contact the armature conductor turns to reduce [~~minimize~~] induced magnetic forces that may deflect the current collectors [~~in a circumferential direction~~].

3. (Amended) A homopolar machine in accordance with claim 1, wherein each of the current collectors comprises a [~~flexible,~~] solid material [~~that is coupled to its respective stator-current collector array so that it bears up against an~~]

~~outer rotating rim of the armature conductor turn with a pressure governed substantially by a spring constant of the flexible, solid material~~].

4. (Amended) A homopolar machine in accordance with claim 1, wherein each of the current collectors comprises a flexible, [~~solid~~] electrically conductive material [~~having spring constant properties that permit a preload pressure on the armature conductor turn to remain substantially constant as the material exhibits limited wear and deflection from external forces~~].